

NON-PUBLIC?: N
ACCESSION #: 9304260241
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Waterford Steam Electric Station Unit 3 PAGE: 1 OF 08

DOCKET NUMBER: 05000382

TITLE: Rx Trip Caused by Age-Related Loss of Inverter and
Protection System Power Supply
EVENT DATE: 03/04/93 LER #: 93-001-00 REPORT DATE: 04/01/93

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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Systems Engineering - Electrical

COMPONENT FAILURE DESCRIPTION:
CAUSE: C SYSTEM: JC COMPONENT: UJX MANUFACTURER: P314
C JC RJX S250
REPORTABLE NPRDS: Y
Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On March 4, 1993 at 2045, Waterford 3 was operating at 100% power when a reactor trip occurred as a result of two nearly simultaneous power supply failures. The failures deenergized elements of two channels of the Plant Protection System (PPS) which satisfied the coincidence logic and resulted in the reactor trip.

The first failure appears to be the result of age-related degradation of a frequency detection card in a static uninterruptible power supply. The second power supply was lost when its supply breaker opened during the subsequent electrical transient. Further analysis indicates that several of the power supply output capacitors were degraded.

In addition to replacing failed components, corrective action will include review of other applications of this equipment and the addition of periodic checks to identify power supply degradation. Since the PPS "failed safe," as expected, and generated the required reactor trip, this event posed no risk to the health and safety of the public.

END OF ABSTRACT

Chart "Required Number of Digits/Characters for Each Block" omitted.

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REPORTABLE OCCURRENCE

On March 4, 1993 at 2045, Waterford 3 was operating in Mode 1 at 100% power when the plant experienced an automatic reactor trip. Just prior to the trip, elements of Plant Protection System (PPS) channel 'C' deenergized as a result of a failed frequency detection card in a static uninterruptible power supply. During the subsequent electrical transient, a power supply failure occurred in PPS channel 'D.' Together, the failures on PPS channels 'C' and 'D' satisfied the necessary coincidence logic and resulted in actuation of the plant protection system and a reactor trip.

The PPS actuation was reported to the NRC via the Emergency Notification System at 2327 CST as required by 10CFR50.72(b)(2)(ii). As an unplanned actuation of the Plant Protection System, this event is reportable as an LER in accordance with 10CFR50.73(a)(2)(iv).

INITIAL CONDITIONS

Plant Power 100%

Plant Operating Mode Mode 1; Power Operation

Procedures Being Performed Specific to this None
Event

Technical Specification LCO's in Effect None
Specific to this Event

Major Equipment Out of Service Specific to None
this Event

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EVENT SEQUENCE

The Waterford 3 Plant Protection System, provided by Combustion Engineering, consists of four independent channels providing, when required, automatic reactor shutdown capability via the Reactor Protection System (RPS; EIIS Identifier JC) and actuation of the Engineered Safety Feature (ESF; EIIS Identifier JE) systems.

The PPS has four redundant input instrument channels for each sensed parameter. A two-out-of-four coincidence of like trip signals is required to generate a reactor trip signal. The fourth instrument channel is provided as a design feature which allows bypassing one channel while maintaining two-out-of-three coincidence protection.

A 120VAC uninterruptible system is provided to supply electrical power to the PPS control and instrumentation channels. The 120VAC system consists of rectifiers/inverters and power distribution panels. Each inverter is normally supplied through its rectifier from a 480VAC ESF Motor Control Center. Should this supply fail, the inverter is supplied automatically from a 125VDC ESF battery. The four rectifier/inverter arrangements are referred to as "static uninterruptible power supplies," or "SUPS," and are designated as channels 'A' through 'D.'

For the purposes of this discussion, each of the four SUPS supplies power to the Core Protection Calculator (CPC; EIIS Identifier JC-CPU) in its respective channel (designated CPC 'A' through CPC 'D') as well as to two PPS power supplies (designated PS1 through PS8). Each of the PPS power supplies, in turn, provides electrical power to one of the four PPS logic units; the

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power supplies are arranged so that each PPS logic unit ultimately receives auctioneered power from both divisions of the electrical distribution system via two different SUPS. This auctioneered power supply arrangement ensures that the loss of a single SUPS or PPS power supply will not result in the loss of a PPS channel (see attached diagram). Complete failure of a PPS power supply results in a PPS power supply trouble alarm in the Control Room.

On March 4, 1993 at 2045, Waterford 3 was operating in Mode 1 at 100% power when a frequency detection card failed in SUPS 'C' causing the SUPS to trip. The loss of SUPS 'C' removed power from the associated Core Protection Calculator (CPC 'C') and caused it to trip as expected on loss of input power. One CPC is provided for each of the four PPS channels to calculate the departure from nucleate boiling ratio (DNBR) and the local power density (LPD); when either of these parameters exceeds a preset

value, a low DNBR or high LPD trip signal is provided to the PPS. As expected, the loss of CPC 'C' resulted in low DNBR and high LPD trips on PPS channel 'C.' With PPS channel 'C' in a tripped condition, a "half trip" was generated in the three (of six total) PPS logic matrices associated with channel 'C.'

The loss of SUPS 'C' also deenergized the two associated PPS power supplies, PS5 and PS6. The loss of PS5, which supplies the PPS logic unit in channel 'C,' did not affect the event because the logic unit was still energized via SUPS 'D' and PS7. The loss of PS6, on the other hand, removed one source of the auctioneered electrical power supplied to the PPS channel 'D' logic unit. In itself, this should not have been a problem because PS8, supplied from SUPS 'D,' should have continued to supply the channel 'D' logic unit.

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However, during the electrical transient that followed the loss of SUPS 'C,' the supply breaker for PS8 appeared to trip open on overcurrent and deenergized the PPS channel 'D' logic unit. As expected, this generated a half trip on the three logic matrices associated with channel 'D.'

The simultaneous half trips on PPS channels 'C' and 'D' satisfied the necessary coincidence logic for the 'CD' matrix and resulted in a reactor trip on low DNBR and high LPD.

As expected for this type of event, the Emergency Feedwater (EFW; EHS Identifier BA-P) pumps and their associated valves were the only ESF equipment that was automatically actuated.

Control Room personnel initiated actions required by Emergency Operating Procedures OP-902-000, "Emergency Entry Procedure," and OP-902-001, "Uncomplicated Reactor Trip Recovery Procedure." The plant was stabilized in Mode 3 (Hot Standby).

CAUSAL FACTORS

The reactor trip was caused by the nearly simultaneous loss of both SUPS 'C' and PPS PS8.

The loss of SUPS 'C' occurred because of a frequency detection card failure. Analysis of the card indicates that the failure may have been the result of age-related capacitor degradation.

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Subsequent analysis of PPS PS8 indicated that the power supply contained three capacitors that were reading significantly lower than their rated value and another capacitor that was demonstrating excessive current leakage to ground. It appears that the excessive leakage condition increased the current drawn by PPS PS8 and caused the feeder breaker to trip on overcurrent.

ACTIONS TO PREVENT RECURRENCE

1. The frequency detection cards in SUPS 'D' and 'C' were replaced. The card in SUPS 'A' will be changed out when a replacement card is available. The frequency detection card installed in SUPS 'B' was replaced after an earlier failure. These cards are currently scheduled to be replaced on a ten year periodicity; this interval will be reviewed and adjusted as appropriate.
2. PPS PS8 was replaced with an updated power supply. After PS8 was replaced, three of the older power supplies remained among the eight PPS power supplies discussed here. These power supplies were checked for any evidence of "ripple," or voltage variation, in the output signal since this can be indicative of power supply degradation. One of the remaining older power supplies, PS4, showed excessive ripple and was replaced; upon further examination, four of the output capacitors were degraded.

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3. Additional checks will be added to the scope of the periodic maintenance performed on the PPS power supplies. For example, as discussed earlier, checking the power supply output for voltage variation (ripple) may be useful in identifying power supply degradation.

The additional maintenance checks of the PPS power supplies and the review of the replacement interval for the SUPS frequency detection cards will be in place by July 14, 1993.

SAFETY SIGNIFICANCE

Since the Plant Protection System failed to a safe condition after the loss of both SUPS 'C' and PPS PS8 and generated a reactor trip as expected, this event posed no risk to the health and safety of the general public or plant personnel.

SIMILAR OCCURRENCES

There have been no similar events reported as LER's. However, SUPS 'B' tripped on December 8th and again on December 15, 1992. After the second trip, the failure was attributed to age-related degradation of capacitors in the frequency detection card. All of the SUPS frequency detection cards were scheduled for replacement during the sixth refueling outage.

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Figure "Plant Protection System Electrical Schematic" omitted.

*** END OF DOCUMENT ***
